

COLEMAN ENGINEERING COMPANY
 635 CIRCLE DRIVE
 IRON MOUNTAIN, MICHIGAN 49801
 Telephone: (906) 774-3440 Fax: (906) 774-7776

PROJECT: Back Forty Wetland Hydrologic Characterization
 CLIENT: Aquila Resources
 BORING LOCATION: 49.45421723° N, 87.82527978° W - See soil boring location drawing
 RIG TYPE: Hand Auger
 DRILLING METHOD:
 DATE STARTED: 5/9/17 DATE COMPLETED: 5/9/17 REVIEWED BY: M. Gotham
 HOLE CLOSURE: Piezometer Installed - See installation diagram

JOB NO.: 17186.GPJ
 BORING NO.: PZ-14A
 1 OF 1
 ELEV.:
 DRILL CREW: M. Graham / J. McDonald / S. Schwartz
 BORING DEPTH: 5.5
 DATE: 6/21/17

SAMPLE NUMBER	SPT VALUES BLOWS/FT	RECOVERY LEGEND	DEPTH (FT)	SOIL DESCRIPTION	WATER TABLE ELEV. (FT)	COMMENTS	TEST RESULTS				
							W	LL	PL	T	q _u
							W	LL	PL	T	q _u
1		1.0	0	(PT) ECLT. Black, fibrous, semi-saturated		Driller's note: Samples wet 0.10' to 5.0'					
			0.5	(UOCL) CLAYEY SAND / CHALKS, brown (7.5YR 4/2), fine, fine coarse gravel, high plasticity, semi-saturated, soft							
2		1.0	1	(SPSM) SILTY SAND, 10YR 5/3, with fine and coarse gravel, with organics, saturated, loose, medium plasticity							
3		1.0	2	(SPSC) CLAYEY SAND, 30% oxidized material, 10YR 5/6, 10% greyed (7.5Y), (SPSC) 10YR 4/6, fine, loose/soft, saturated, high plasticity							
4		1.0	3	(SPSM) SILTY SAND, 10YR 4/3, fine, with coarse sand, saturated, slight plasticity							
5		1.0	4	(SPSC) CLAYEY SAND, 2% greyed material (8/10Y), (SPSC) 10YR 6/6, saturated, high plasticity, soft							
6		0.5	5	(SPSC) CLAYEY SAND, 2.5Y 4/3, fine, with coarse gravel, 2% organic matter, black to charcoal, coarse black fragments (few), saturated		Driller's note: Hand drilling 5.0' to 5.5'					
			5.5	(SPSC) CLAYEY SAND, 2.5Y 4/3, fine, with coarse and fine gravel, with coarse sand, saturated, high plasticity, loose							
Auger Drilling Refusal and End of Boring											

Soil Boring PZ-14A is ion WL B3.

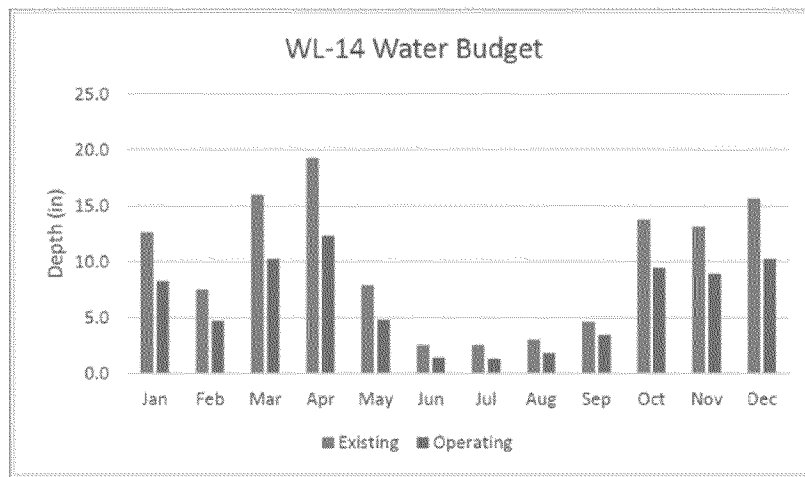

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 Telephone: (506) 774-3440 Fax: (506) 774-7776

PROJECT: Back Forty Wetland Hydrologic Characterization
 CLIENT: Aquila Resources
 BORING LOCATION: 45.44474414° N, 87.81451070° W - See soil boring location drawing
 RIG TYPE: Hand Auger
 DRILLING METHOD: Hand Auger
 DATE STARTED: 5/10/17 DATE COMPLETED: 5/10/17
 HOLE CLOSURE: 3/8" Bentonite Chips & Soil Cuttings

JOB NO.: 17189.GPJ
 BORING NO.: SB-1
 1 OF 1
 DRILL CREW: M. Graham / J. McDonald
 BORING DEPTH: 5.6
 REVIEWED BY: M. Gotham DATE: 6/21/17

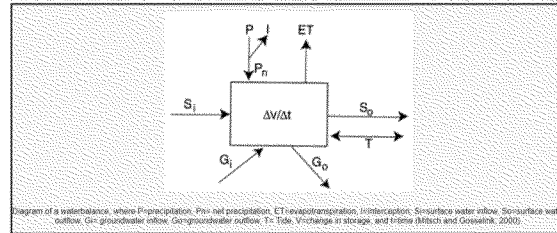
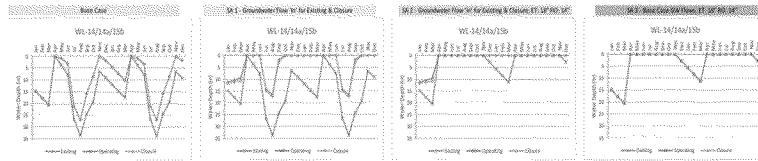
SAMPLE				SOIL DESCRIPTION	WATER TABLE ELEV. (FT)	COMMENTS	TEST RESULTS			
NUMBER	SPT VALUES BLows/ft	RECOVER	LEGEND DEPTH (FT)				+4 -4 -20v	MOISTURE CONTENT (%)	L L (%)	P L (%)
1		1.0	0	(PT) PEAT fibrous, black, semi-saturated	0.0	Driller's note: Samples wet 0.5' to 6.0'				
2		1.0	1	(PT) PEAT sedimentary, black, semi-saturated	1.1					
				(SP) CLAYEY SAND, 2.5V 4/2, coh. fine, medium to high plasticity, saturated	1.0					
3		0.9	2	(SP) CLAYEY SAND, 2.5V 6/2, saturated, medium dense, slight plasticity, fine, 2% mottles 2.9V 5/4	2.0					
				(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine	3.0					
4		1.0	3	(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine	3.0					
				(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine	4.0					
5		1.0	4	(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine	4.0					
				(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine	5.0					
6		1.0	5	(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine, 1% mottles 2.9V 5/4	5.0					
				(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine, 1% mottles 2.9V 5/4	5.7					
				(SP) SAND SILTY SAND, 2.5V 5/2, saturated, medium dense, slight plasticity, fine, 1% mottles 2.9V 5/4	6.0					
				End of Boring	6.0					

SB-1 should be from near PZ-1/1A



Comments on Wetland Watershed Budgets

- The wetland watershed budgets presented used data collected from NOAA and NRCS and are not unique to the site. Two years of meteorological data has been collected onsite and was included with the Part 632 application, but was not used as either a parameter or to verify the offsite data.
- Wetland watershed budgets should typically represent wet, dry and average years. The data used represents a mean monthly average. This does not provide representation of annual or monthly precipitation variation and is less predictive of hydrological fluctuations during the growing season.
- This water budget assumes that each wetland has unlimited storage capacity and that water accrues within a wetland until the water infiltrates or exfiltrates. The budget fails to recognize that most wetlands have a natural outlet. WL B1/B2/B1c discharges through a perennial stream, which dips underground at the sandstone pinch-out and reemerges before discharging into the Menominee River. WL C1/40/41 discharges through two streams directly to the Menominee River. WL-6 channelizes before dipping underground at the sandstone pinch-out. WL 2B/A3/A1 channelizes and flows south to the Shakey Lakes system. WL 14/14a/15b has evidence of channelization but is also historically disturbed to the extent that the natural discharge point is poorly defined. Each onsite wetland complex demonstrates that it is a discharging system.
- Monthly infiltration/ exfiltration rates. The notes indicate that these rates were determined from slug tests that have been conducted onsite. To our knowledge, there have been no slug tests that have been conducted for wetland values; slug tests have been conducted in upland areas. The infiltration rate is a constant throughout the year, which does not factor in frozen soils when infiltration does not occur and higher infiltration rates in much of the growing season when the water table is likely below the soil surface.
- Using a wetland watershed contribution runoff coefficient that is applied to the total monthly rainfall is not appropriate. It is recommended that the NRCS's TR-55 method is used to determine runoff created by individual rainfall events over a specified value based upon watershed contribution, land cover, and soil types.
- The wetland watershed budgets assume that two weeks of soil saturation during the growing season is sufficient to support the existing wetland community. This assumption is unsupported. The existing wetland community relies on the existing hydrologic regime within the watershed. Alterations to the existing watershed budget may constitute an impact. The applicant should have a baseline of the hydrologic and environmental (climatic, chemical, etc.) conditions that support the existing community and provide an assessment of the changes to the baselines conditions and conclusion of impacts.



Standard, basic model of a wetland watershed budget (Mitsch and Gosselink, 2000). The model includes surface water inflow and outflow, groundwater inflow and outflow, precipitation, interception and evapotranspiration.

This information should be contained in one model that represents each wetland watershed. Each model should clearly define the proposed alterations to the existing hydrology. The current model omits interception rates, surface water outputs, storage capacity by wetlands, and groundwater inputs and outputs for each system.

Indirect Wetland Impacts

While the overall wetland water budget indicates that there is sufficient runoff and precipitation to support a wetland (Figure 5-57 and Figure 3, MDEQ Response March 2018), our assessment indicates that there may be a localized alteration of wetland hydrology adjacent to the pit. The indirect wetland impacts assessment indicates that approximately 6.18 acres will be impacted based on proximity (Table 5-2). The impact to wetland hydrology will be due to altering the size of the watershed from 57 acres to 36 acres.

Questions...

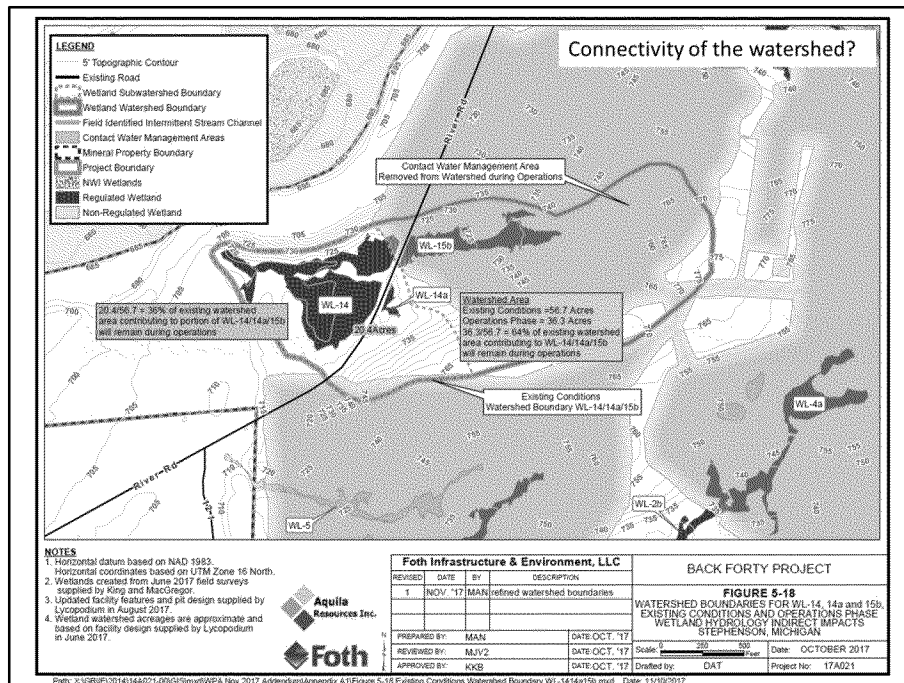
- What is "proximity"? How was the threshold for "proximity" impacts decided?
- How does the location of River Road effect the existing hydrology of the wetland? The watershed area that is defined on figure 5-18 currently does not support wetland 14 with surface water inputs.
- If the impact to this watershed is due to alteration of the size of the watershed from 57 acres to 36 acres, what about other wetlands that lose a comparable percentage of their wetland watersheds?

Conclusion presented by Foth in document sent to Kim on 3/16.

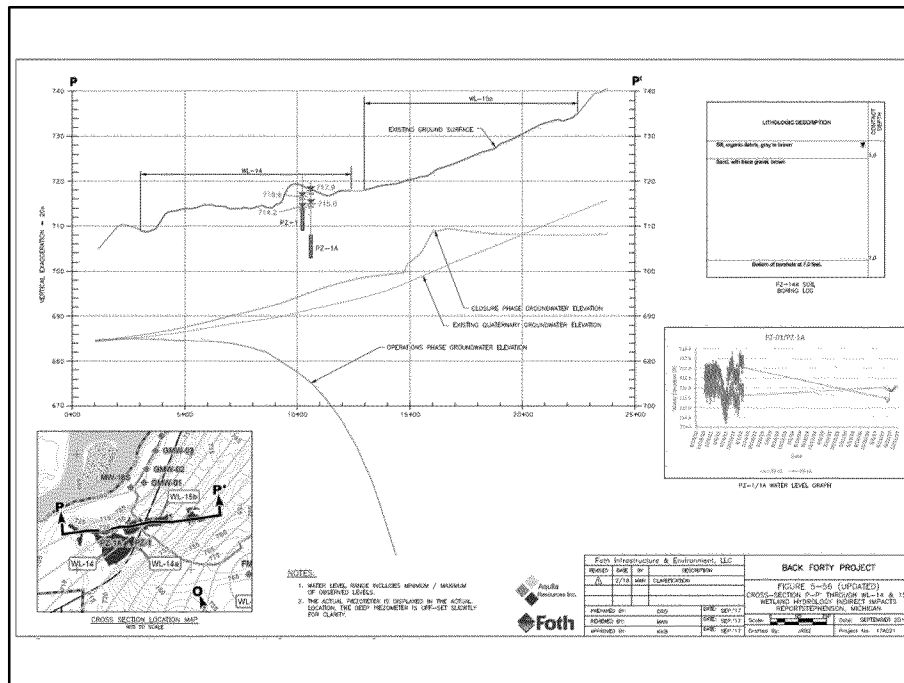
	Wetland complex	Wetland acreage	Existing contributing upland drainage	Operations Contributing Upland Drainage	Change in wetland area	Operations watershed remaining	Proposed impacts (hydrology and proximity)
2b		6.12	108	19	0	0.18	1.88
14		6.15	56.7	36.3	0	0.64	6.28
40/41		1.08	36	23	0	0.64	0
A1		1.9	57	12	0	0.21	1.93
A3		1.5	113	55	0	0.49	1.52
B1		4.49	124	83	0	0.67	1.34
B1c		0.83	46.6	28	0	0.60	0.22
C1		4.2	92	21	0	0.23	4.16

Data collected from wetland watershed budgets, existing and operations conditions.

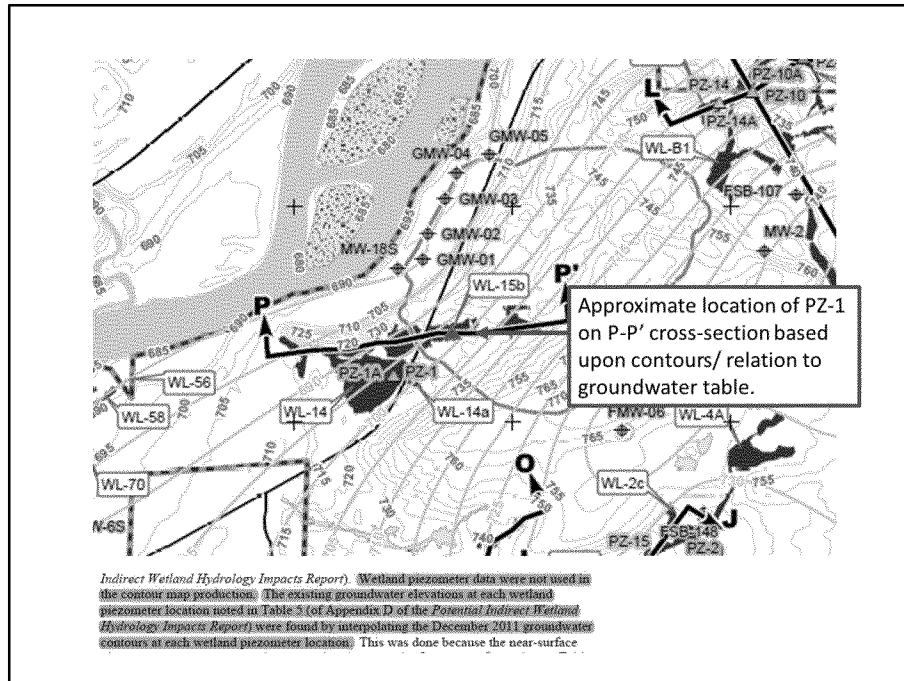
Wetland 14/14a/15b



River Road is a barrier to surface hydrology. No evidence of adequate equalization through River Road. How does the wetland watershed portrayed in this figure support WL-14?

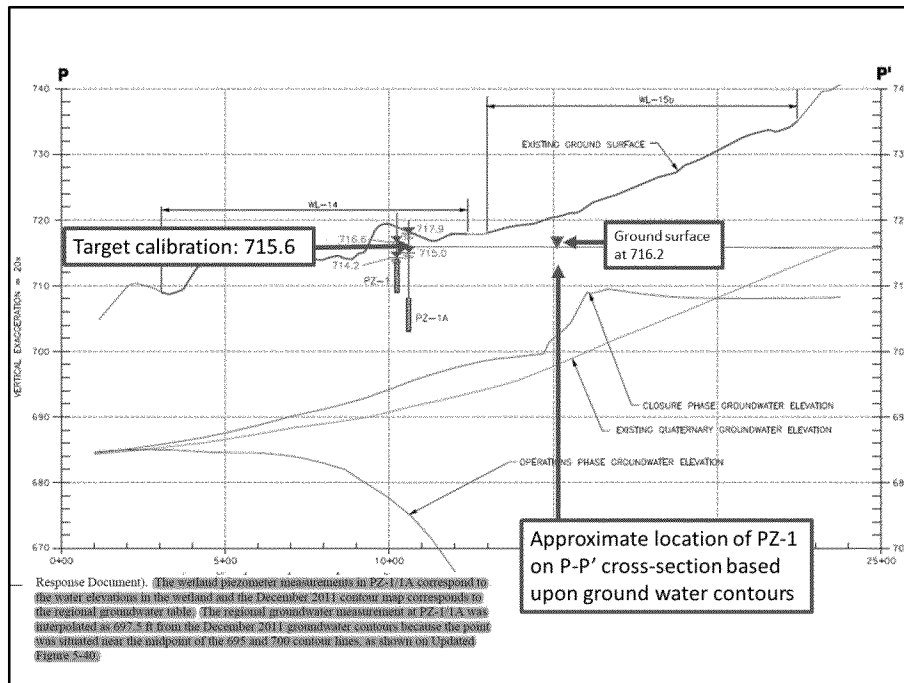


This figure represents the location of the piezometer nest in relation to the groundwater table.

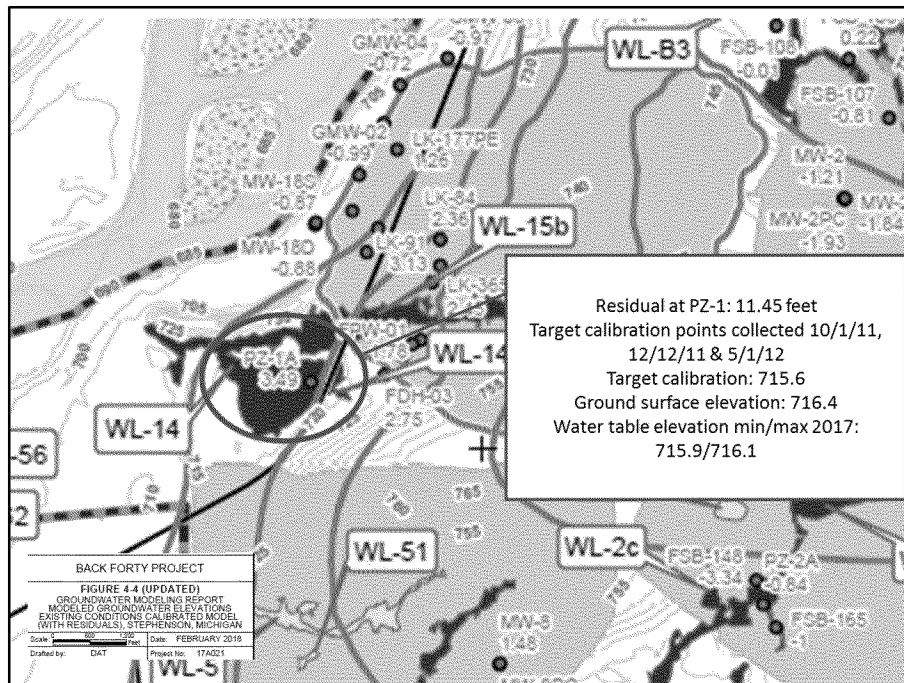


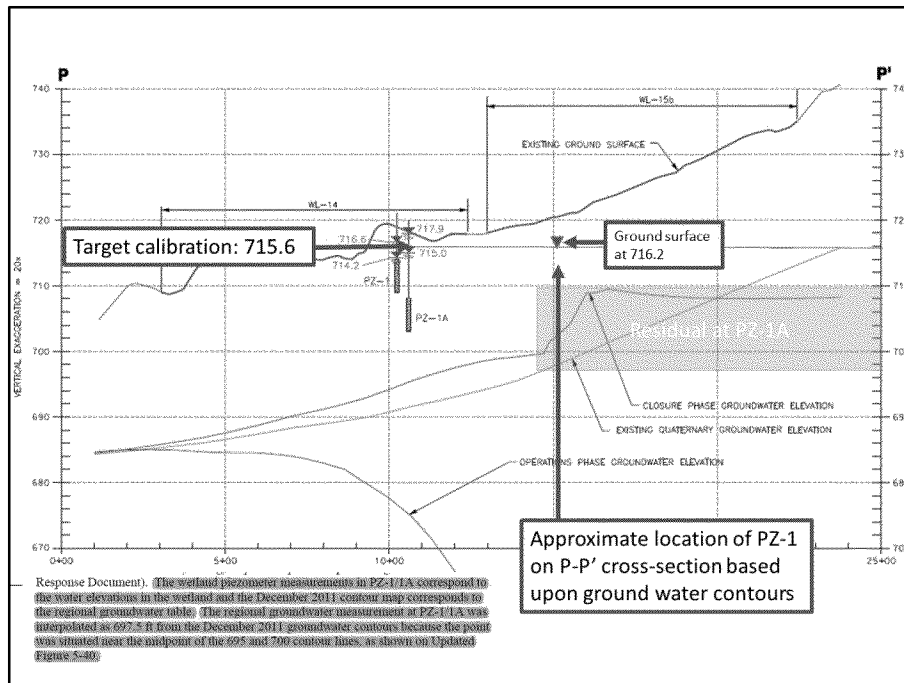
PZ1/1A is shown on Table 1 (In March response) as a target for the groundwater model calibration. It is also shown on Figure 4-4 (Updated) as having a residual.

PZ-1/ PZ-1A is shown on the cross-section contours for P-P'; however, the location of PZ-1/PZ-1A is off-set and is represented in cross-section as being in WL-14. Figure 5-56 states that the piezometer is off-set but shown in the correct location. This is the incorrect location of the piezometer since the purpose of cross-section (P-P') is demonstrate the groundwater elevation at PZ-1/PZ-1A in comparison with the modeled groundwater elevation (aka regional groundwater table). This slide shows where the location of PZ-1/PZ-1A would exist if it was located on the P-P' cross-section. The following slide shows the onset location of the piezometer relative to the cross-section and representation of the groundwater model.

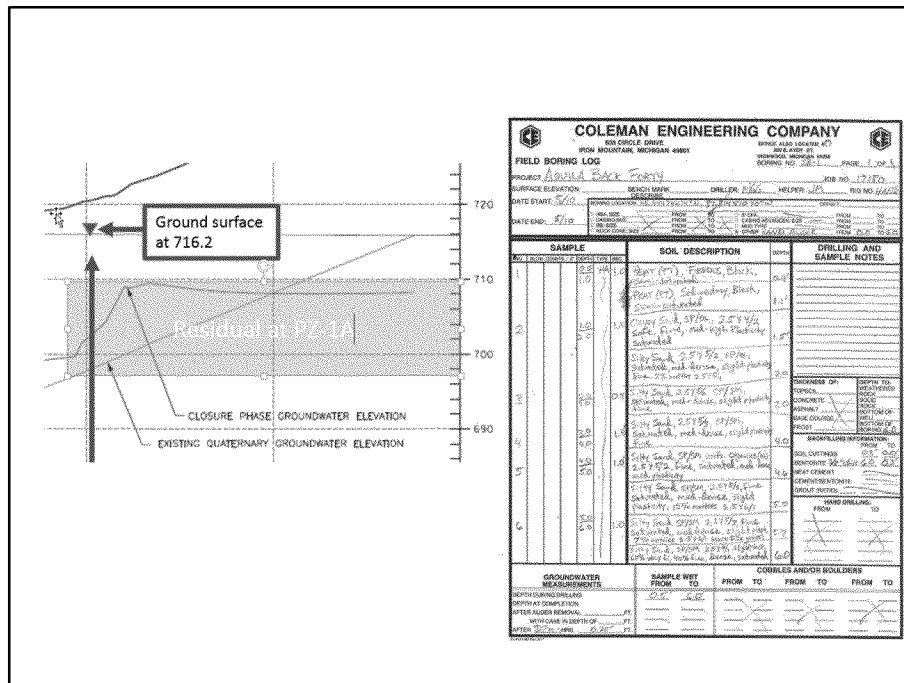


This slide shows cross-section P-P'. Note that on this slide, PZ-1/PZ-1A is shown in WL-14. However, this is the incorrect location. The P-P' cross-section is significantly off-set from the actual location of PZ-1/ PZ-1A. If you follow the elevation contour on the previous slide, the piezometer nest is located between in about the middle of WL-15. This slide shows approximately where the piezometer nest would sit relative to the regional water table if the piezometer nest were accurately represented on the cross-section. If the piezometers were accurately represented on the cross-section, we would have a better representation of the water table elevation that is both supported by the calibrated targets, piezometer data and the residuals.

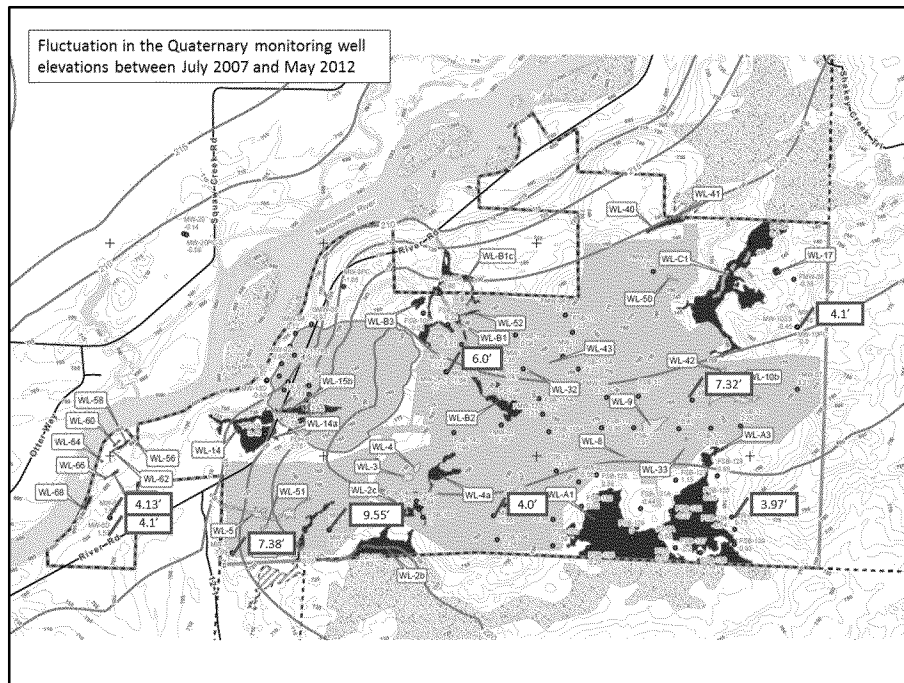




This slide shows cross-section P-P'. Note that on this slide, PZ-1/PZ-1A is shown in WL-14. However, this is the incorrect location. The P-P' cross-section is significantly off-set from the actual location of PZ-1/ PZ-1A. If you follow the elevation contour on the previous slide, the piezometer nest is located between in about the middle of WL-15. This slide shows approximately where the piezometer nest would sit relative to the regional water table if the piezometer nest were accurately represented on the cross-section. The distance to the modeled water table at this location is comparable to the residual in the model of 11.45 feet. I believe that if the piezometers were accurately represented on the cross-section, we would have an accurate representation of the water table elevation that is supported by the calibrated targets, piezometers and the residual.

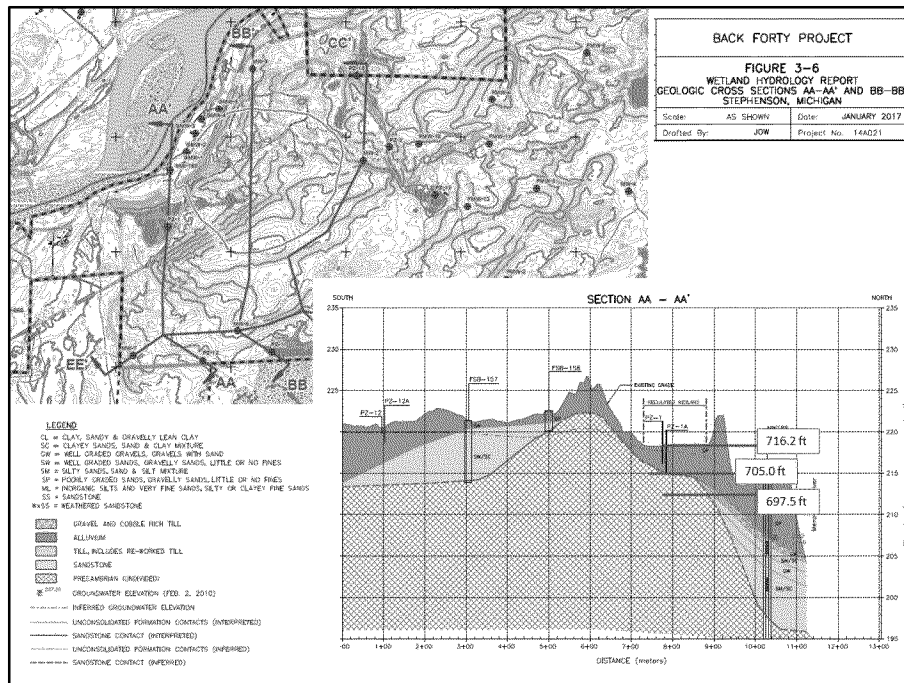


The soil boring shows that the area above the residual to ground surface is saturated sand.



The calibrated target values for the ground water model were created by averaging the minimum and maximum elevations recorded at monitoring wells, piezometers and soil borings within and near the project site. The values represented in this slide are the differences between the minimum and maximum recorded elevations at some of the monitoring wells located on the project site. Data taken from Table 1, Groundwater Model Target Calibration Points and Values, from the March 8 response to clarification and amplification.

The values represented on this slide have more than one season of target data, and they include collection during the growing season which represents seasonal variation in the water table. All of these targets were collected from the Quaternary. Several of the target locations that we are interested in, such as FMW-05, FMW-08, PZ-1A, PZ-5/PZ-5A do not have any data collection periods during the growing season. This range of elevation is well within the fluctuation zones of what would impact wetland hydrology.



This figure was included in the January 2017 submission, the previous wetland application submission and in the 632 application. This shows a cross-section that incorporates that actual location of water table.

Also, of note, is that Figure 3-6 shows that the Precambrian layer (bedrock) sits at 705.38 feet at PZ-1/1A. By asserting that the groundwater elevation at PZ-1/1A is at 697.5, it is also saying that all of the groundwater is flowing through the Precambrian and not through the alluvium.

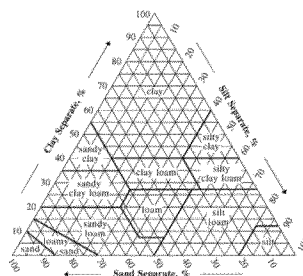
PZ-1/ PZ-1A and represents the location of the water table that is supported by the conclusions of the previous slides.

C-C', WL-C1

SOIL DESCRIPTION

(P2A) SAND , black, fibrous, saturated, loose	0.4'
(G1C1) CLAYEY SAND , 3% GY G1, fine, fibrous, slightly, medium to high plasticity, saturated, dense	1.0'
(SP1M) SAND , 7.5 YR G4, 1% mottles, very fine to fine, non to slightly plastic, saturated, medium dense	2.0'
(SP1M) SILTY SAND , 7.5 YR G4, 15% mottles 10 YR G8, 60% very fine, 30% fine, 10% medium, slight plasticity, saturated, dense	3.0'
(SP) SAND , 7.5 YR G4, 5% mottles 10 YR G8, 60% very fine, 30% fine, 10% medium, trace coarse, trace silty, slightly plastic, saturated, dense	4.0'
(SP) SAND , 40% very fine, 40% fine, 20% medium with coarse sand and fine gravel, non plastic, unsaturated, medium dense	5.5'
(H4) CLAYEY GY , 7.5 YR G4, high plasticity, soft, fine to medium, medium dense	6.0'

End of Boring

PZ-21A SOIL
BORING LOG

FINE-GRAINED SOILS	Ribbous	1iquid Limit	Dry Cracking Strength	Dilatancy Reaction	Toughness	Stickiness
More than half the material (by weight) in individual grains not visible to the naked eye	None	<30	High to Very High	Rapid	Low	None
	Weak	<50	Medium to High	None to Very Slow	High to Very High	Medium
	Strong	>50	Slight to Medium	Slow to None	Medium	Low
(=0.075 mm)	Very Strong	>60	High to Very High	None	High	Very High

<p>SANDY SOILS More than half of coarse fraction is smaller than 475 microns</p>	<p>CLEAN SAND Will have a single size soil profile</p>	<p>Will range in grain size and sedimentary sources of all grain particle sizes</p>	<p>SW</p>
		<p>Gradually will have a range of sizes with some characteristic zone mixing</p>	<p>SP</p>
	<p>DIRTY SANDS Will have a more or less pale</p>	<p>Will have thin (loessity, not ML, heavy)</p>	<p>SM</p>
		<p>Plastic (due to silty), not CL, heavy</p>	<p>SC</p>

- NOTE:
DRILL LOGS NOTED SEMI-SATURATED CONDITION
(I.E. UNSATURATED CONDITIONS EXIST)

Wetland C1

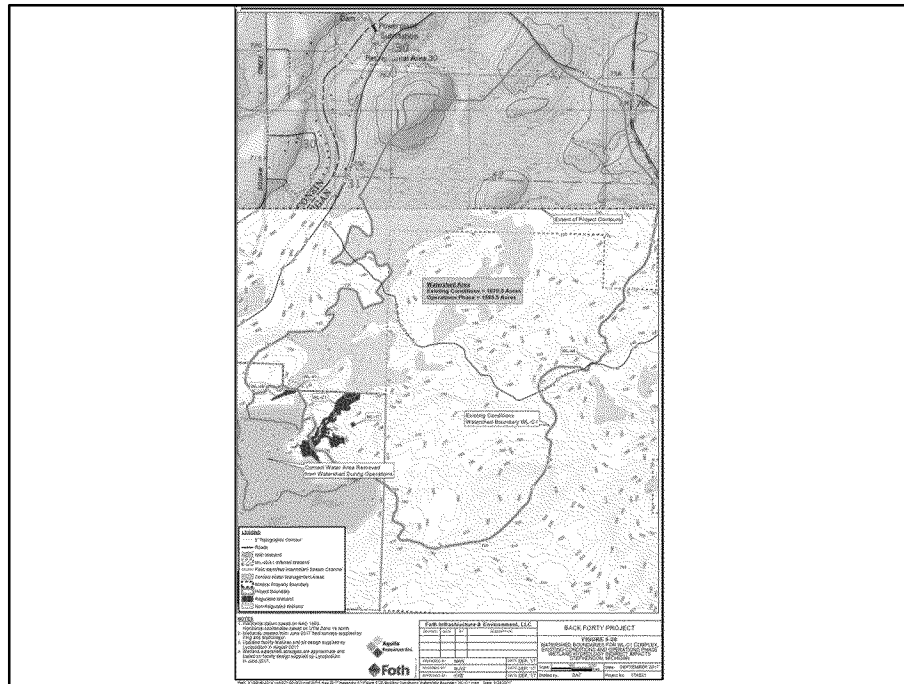


Table 4-1 Wetland Water Balance Analysis, Current Conditions													
Wetland ID	Wetland Area (ac)	Water Source ¹	Wetland Area (ac)	Wetland Area Removed from Tributary Contribution (ac)	Percent Original Wetland Area Lost (%)	A _W Net Watershed Area: Tributary Watershed Area minus Wetland Area (ac)	Runoff to WL (FT ³ /SEC ET ² /A _W)	Precipitation Directly on WL (in/yr)	Wetland Seepage to Groundwater (in/yr)	Groundwater Seepage to Wetland (in/yr)	Evaporation from WL (in/yr)	Evaporation from WL (in/yr)	Water Supply to Wetland as Percent of ET
WL-B3	0.45	Surface Water Dominates	5.42	0	0%	4.97	1E+05	1E+04	1E+04	Zero	18	1E+04	50%
WL-B1c	0.7	Surface Water Dominates	46.5	0	0%	45.8	1E+06	1E+04	1E+04	Zero	18	1E+04	134%
WL-40/41	1.3	Surface Water Dominates	22.57	0	0%	21.27	1E+05	1E+05	1E+04	Zero	18	1E+04	681%
WL-C1	341.73	Mixed (Groundwater and Surface Water)	1857.58	0	0%	1515.85	1E+07	4E+07	1E+06	1E+06	18	1E+07	309%
WL-2b-A1/A3	251.58	Mixed (Groundwater and Surface Water)	774.6	0	0%	523.02	1E+07	1E+07	1E+06	1E+06	18	1E+07	208%

¹ Runoff to wetland based on 31.07 in/yr precipitation, 7 in/yr recharge to groundwater, and 18 in/yr evapotranspiration.

² See Wetland Hydrology Report, Appendix C-11 of Permit Application.

³ Groundwater discharge/recharge obtained from GW flow model for C1 and 2b-A1/A3. No GW flow to B1c, B3, and 40-41 due to perched setting; seepage from WL to groundwater set equal to USGS rate of 7 in/yr.

ac = acre
in/yr = inches per year
ET = evapotranspiration

Prepared by: DSD
Checked by: KCB

Table 4-2 Wetland Water Balance Analysis, Peak Operating Conditions													
Wetland ID	Wetland Area (ac)	Water Source ¹	Wetland Area (ac)	Wetland Area Removed from Tributary Contribution (ac)	Percent Original Wetland Area Lost (%)	A _W Net Watershed Area: Tributary Watershed Area minus Wetland Area (ac)	Runoff to WL (FT ³ /SEC ET ² /A _W)	Precipitation Directly on WL (in/yr)	Wetland Seepage to Groundwater (in/yr)	Groundwater Seepage to Wetland (in/yr)	Evaporation from WL (in/yr)	Evaporation from WL (in/yr)	Water Supply to Wetland as Percent of ET
WL-B3	0.45	Surface Water Dominates	5.42	0.0	0%	4.97	1E+05	1E+04	1E+04	Zero	18	1E+04	50%
WL-B1c	0.7	Surface Water Dominates	46.5	10.6	23%	35.9	1E+05	1E+04	1E+04	Zero	18	1E+04	184%
WL-40/41	1.3	Surface Water Dominates	22.57	4.0	18%	17.57	1E+05	1E+05	1E+04	Zero	18	1E+04	51%
WL-C1	341.73	Mixed (Groundwater and Surface Water)	1857.58	25.9	1%	1731.72	1E+07	4E+07	1E+06	1E+06	18	1E+07	309%
WL-2b-A1/A3	251.58	Mixed (Groundwater and Surface Water)	774.6	175.3	23%	599.3	1E+07	1E+07	1E+06	1E+06	18	1E+07	214%

¹ Runoff to wetland based on 31.07 in/yr precipitation, 7 in/yr recharge to groundwater, and 18 in/yr evapotranspiration.

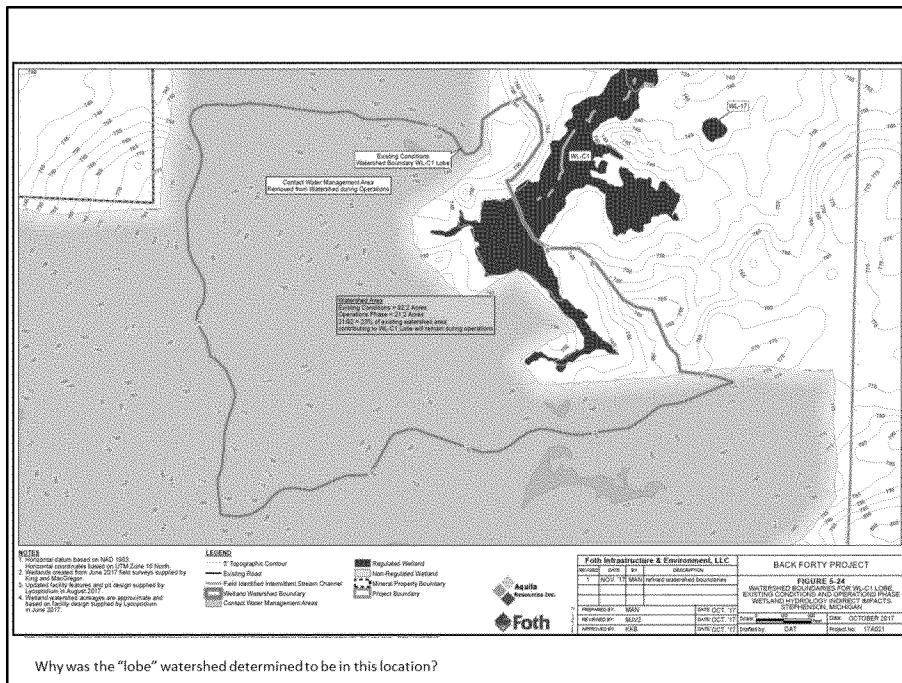
² See Wetland Hydrology Report, Appendix C-11 of Permit Application.

³ Groundwater discharge/recharge obtained from GW flow model for C1 and 2b-A1/A3. No GW flow to B1c, B3, and 40-41 due to perched setting; seepage from WL to groundwater set equal to USGS rate of 7 in/yr.

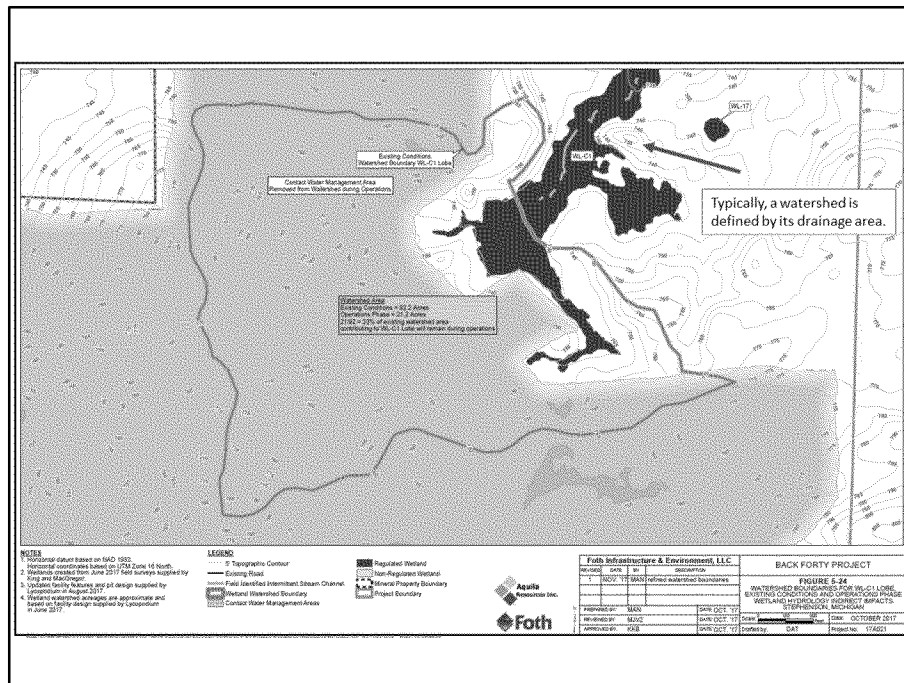
ac = acre
in/yr = inches per year
ET = evapotranspiration

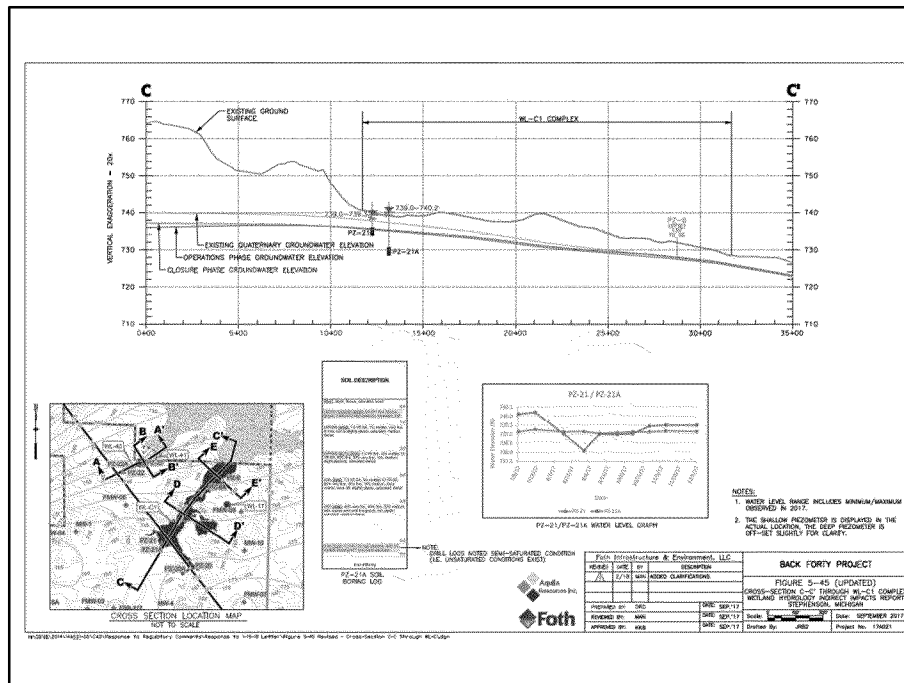
Prepared by: DSD
Checked by: KCB

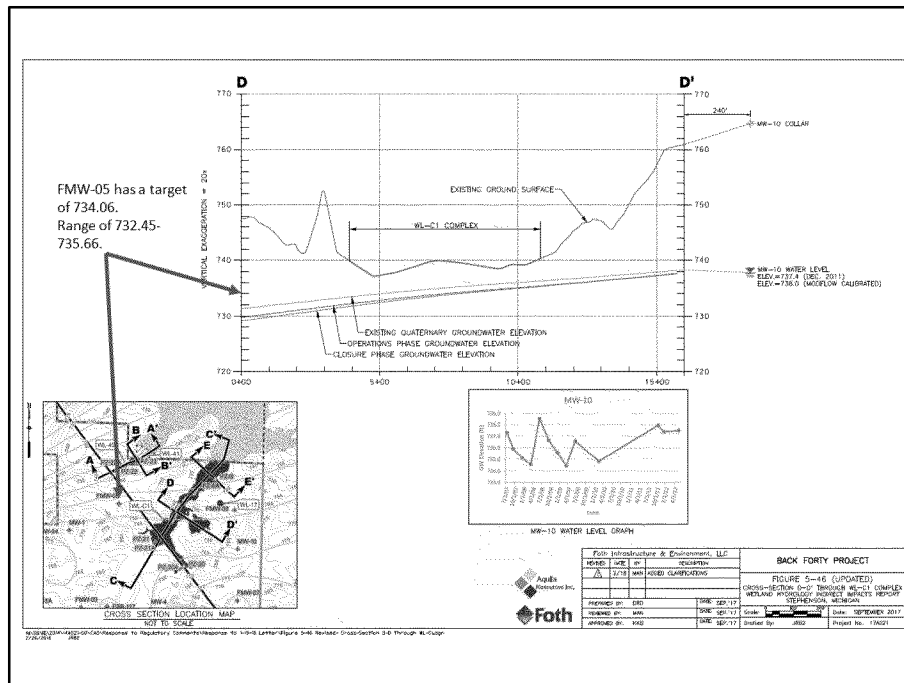




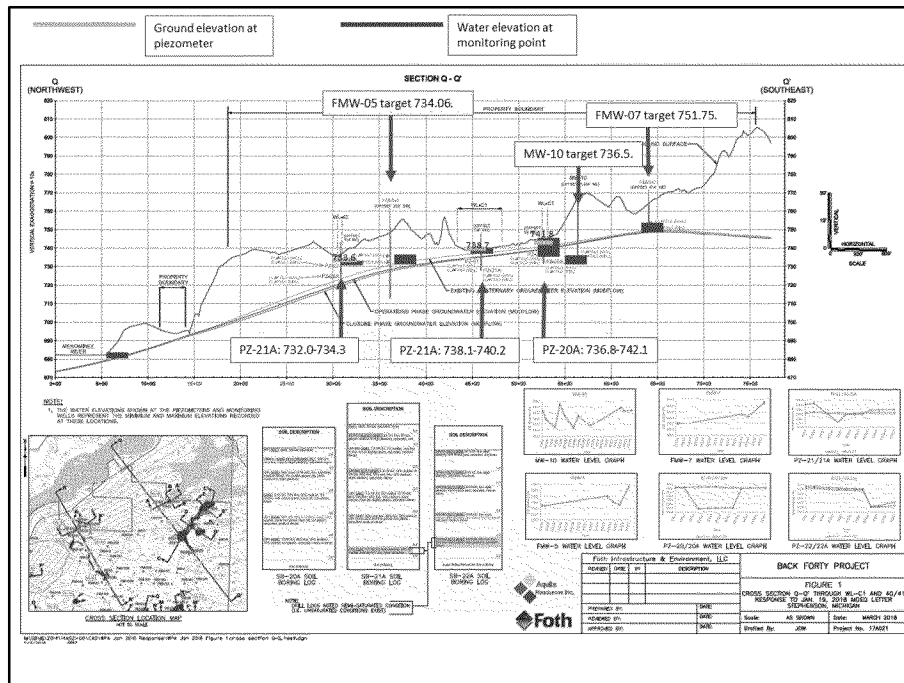
Why was the "lobe" watershed determined to be in this location?







At some place, the GW elevation has to go up.



Cross-section is off-set from PZ21/21A in WL-40/41 and FMW-07

Impact Assessment of Groundwater Drawdown

Wetland C1

The surface water hydrology in this wetland is dependent on groundwater and surface water (precipitation and runoff) and is considered a valley bottom wetland. The impact assessment determined that the dewatering operation will have an adverse impact on surface water in approximately 4.16 acres of this wetland. The following information (Updated Figures 5-45 to 5-47 and New Figure 1), was used to determine the extent of the impact to wetland hydrology:

Wetland A1

(1)

The surface water hydrology in this wetland is dependent on groundwater and surface water (precipitation and runoff) and is considered a valley bottom wetland. The impact assessment determined that the dewatering operation will have an adverse impact on surface water in approximately 1.93 acres of this wetland. The following information (Updated Figures 5-48 and 5-49) was used to determine the extent of the impact to wetland hydrology:

The extent and magnitude of the adverse impact was determined to be limited to the southern end of Wetland C1 for several reasons. First, the existence of a clay layer 5.5 ft below the surface (Piezometer 21/21A driller log on Updated Figure 5-45) may act to mitigate the impact of the water level drawdown. Second, the groundwater model shows that the drawdown due to dewatering operations does not extend to the northern end of Wetland C1 (Updated Figure 5-47). In the middle of Wetland C1, the groundwater drawdown is estimated to be approximately 1 ft (Updated Figure 5-46). While the groundwater is expected to drop, the wetland water balance model shows that there is adequate surface water (precipitation and runoff) to mitigate the impact of a groundwater drawdown (see water balance summaries).

EXISTING CONDITIONS

Net MODFLOW Flux From Wetland (in/mo/unit wetland area) (neg value is flux to wetland)	
Wetland ID	
WL-C1 Complex	-0.153260006
WL-2b/A1/A2 Complex	-0.34780232
WL-A1 East, North Lobe	-2.549413371
WL-A1 West, North Lobe	-3.648039649

PROPOSED CONDITIONS

Net MODFLOW Flux From Wetland (in/mo/unit wetland area) (neg value is flux to wetland)	
Wetland ID	
WL-C1 Complex	-0.124702241
WL-2b/A1/A2 Complex	0.086447976
WL-A1 East, North Lobe	-0.11084406
WL-A1 West, North Lobe	-0.15414252

Table 4
Regional Water Table Drawdown Near
Wetlands (MODFLOW)

Reference Point	Drawdown (ft)	Drawdown (m)
C1-a	1.75	0.53
C1-b	2.40	0.73
C1-c	1.25	0.38
C1-d	0.35	0.08
40/41-a	2.75	0.84
40/41-b	1.75	0.53
B1-a	23.0	6.71
B1-b	3.75	1.14
B1-c	7.30	2.29
B1-d	12.0	3.66
B1-e	8.50	2.59
14-a	25.0	6.71
14-b	7.30	2.29
6-a	0.60	0.18
2b-a	0.25	0.08
A1West-a	2.50	0.76
A1West-b	0.35	0.11
A1East-a	1.30	0.40
A1East-b	0.10	0.03

1) See Figure 1 (Updated); taken from Figure 5-5 of Groundwater Modeling Report
2) Drawdowns < 0.5 ft were extrapolated from Figure 1 (Updated)

Prepared by: DRD
Reviewed by: MLAN

A clay layer was documented at PZ 21-21A but not at PZ 20/20A or PZ 6/6A.

Table 3-1
Wetland Impact Summary
MDEQ Wetland Permit Application
Aquila Resources Inc. - Back Forty Project
October 16, 2017

On-site Registered Wetland ID	Total Substantiated Wetland Size (acres)	Wetland Size Within Project Boundary					Proposed Wetland Direct Impacts ¹			Proposed Wetland Indirect Impacts ² (acres)	Total Proposed Wetland Impacts ³ (acres)	Total Impacts by Wetland Type (acres)		
		Area (acres)	Max Length (feet)	Max Width (feet)	Max Depth (feet)	Average Depth (feet)	Average	Fill or Excavation Volume	Cross Section Detail Location in Project Plans			PEM	PS	PFO
WL-14	0.15	0.15	982	762	2.5	2.0	0.13	1,980 CY Excavation (0.13ac)	Figure 4-5	0.15	0.28	-	-	0.28
WL-14a	0.10	0.10	205	116	1.0	0.5	-	-	-	0.03	0.03	-	-	0.03
WL-15b	2.24	2.24	968	260	2.5	2.0	2.24	968,560 CY Excavation (2.24ac)	Figure 4-5	-	2.24	1.13	-	1.11
WL-20	0.40	1.02	1581	489	2.0	1.0	1.17	45,750 CY Fill (1.17ac)	Figures 4-6 and 4-9	0.94	2.25	-	-	0.28
WL-22	0.10	0.10	506	55	1.0	0.5	0.10	13,382 CY Fill (0.10ac)	Figure 4-11	-	0.10	-	-	0.10
WL-B1c	0.02	0.02	216	168	1.0	0.5	0.16	2,403 CY Fill (0.16ac)	Figure 4-10	0.06	0.22	-	-	0.22
WL-B3	2.85	2.85	1666	373	2.0	1.0	2.85	421,860 CY Fill (2.85ac)	Figure 4-6	-	2.85	2.24	-	0.61
WL-6	4.93	1.33	1113	125	1.0	0.5	1.23	242,350 CY Fill (1.23ac)	Figure 4-6	0.10	1.33	-	-	1.33
WL-4a	1.90	1.90	490	510	1.5	0.5	1.79	57,840 CY Excavation (1.79ac)	Figure 4-7	-	1.79	1.79	-	-
WL-2c	1.40	1.40	718	580	3.0	0.5	1.40	13,890 CY Fill (0.25ac)	Figure 4-7	-	1.40	1.40	-	-
WL-A1	40.83	40.83	3918	1349	3.0	2.0	-	-	-	1.93	1.93	-	-	1.93
WL-C1	15.84	15.84	2137	1371	2.0	1.0	-	-	-	4.16	4.16	-	-	4.16
Wetland	61.07	-	-	-	-	-	-	-	-	-	-	-	-	61.07
WL-2b	0.12	0.12	642	1117	3.0	1.5	-	-	-	1.84	1.80	-	-	1.80
WL-B3	0.51	0.51	244	132	2.0	1.5	-	-	-	-	-	-	-	-
WL-40-41	1.08	1.08	497	117	1.0	0.5	-	-	-	-	-	-	-	-
Total	91.0	95.3	-	-	-	-	11.2	968,850 CY Excavation (2.24ac) 803,471 CY Fill (1.96ac)	-	27.3	28.4	10.6	-	17.8

Total Direct Wetland Impacts¹: 11.2
Total Indirect Wetland Impacts²: 17.3
Total Wetland Impacts³: 28.4

Prepared by: M/VJ
Checked by: MAN

Notes:
PEM = Potential Eutrophic Wetland
PS = Potential Freshwater Wetland
PFO = Potential Forested Wetland
CY = Cubic Yards

¹ Includes PFO based on forested wetland direct impacts (45%) to submersive stream vegetation and PFO based on forested wetland indirect impacts to submersive stream vegetation at wetland WL-B1.

² Includes potential impacts defined by hydrology model and by proximity to site facilities.

WL-C1 Lobe and WL-A1 West-North Lobe are predicted to experience a seasonal water level drop of anywhere from 20 inches to 25 inches that they do not experience under existing conditions. These indirect hydrologic impacts (alongside the impacts due to direct impacts) are summarized in Table 5-1 and on Figure 5-61, and equal 6.1 acres of wetland. None of the remaining wetlands showed a lack of spring surface saturation or a seasonal fluctuation that is any different than the existing condition of each wetland.

Accordingly, an indirect proximity impact was proposed if more than 50% of an existing contributing watershed area for any given wetland (or portion of any given wetland) becomes occupied by the project during operations. It should be noted that, although these contributing watershed areas are used to define 'potential indirect impacts due to proximity' (or indirect proximity impacts), the surface runoff that is associated with these contributing wetland watershed areas do not provide the sole source of water recharge to any wetland under consideration, as these wetlands also receive recharge from adjacent watersheds in the wetland complex through seepage and overland flow.

In any event, using the "50% criteria" for determining potential indirect proximity impacts, wetlands WL-14, WL-14a, WL-A3 Lobe, WL-2b Lobe, and small, on-site portions of WL-6, WL-B1c, and WL-B1 are more likely to be indirectly impacted. These impacted wetlands total 11.1 acres (Table 5-2 and Figure 5-62). Therefore, the total indirectly impacted wetland area, as determined by both hydrologic modeling and proximity criteria, would be 17.2 acres. None of the remaining wetlands under consideration would have more than 50% of its watershed removed, and in the case of each one, the respective hydrographs for each wetland show that there is ample water during springtime and little fluctuation during the remainder of the growing season.

Table 4-1
Aquila Wetlands
Wetland Piezometer Water Elevations
and Vertical Gradient Summary - 2017

Event Date Piezometer ID	Water Elevation (m msl)		Vertical Gradient (m/m)	
	7/6 - 7/10 2017	7/21 - 7/24 2017	7/6 - 7/10 2017	7/21 - 7/24 2017
PZ-06	222.73	223.00		
PZ-06A	223.43	223.39	-0.376	-0.207
PZ-20	226.21	226.22		
PZ-20A	226.20	226.21	0.011	0.009
PZ-21	225.29	225.33		
PZ-21A	225.59	225.62	-0.180	-0.174
PZ-22	223.76	223.77		
PZ-22A	223.83	223.82	-0.044	-0.034
PZ-23	223.21	223.21		
PZ-23A	223.27	223.24	-0.046	-0.028
PZ-24	220.87	220.87		
PZ-24A	220.89	220.87	-0.026	-0.010

Piezometers from C1 complex. PZ-20 is from portion of WL-C1 that is overlying clay soils. PZ-21A is located at the far SW end (beginning of) WL-C1. PZ 22/22A and 23/23A are in WL 40/41.

Vertical Hydraulic Gradient (Green=Downward, Orange=Neutral, Red=Upward)										
WL1 July 4 to 10, 2017	WL2 July 21 to 24, 2017	WL3 August 15-20, 2017	WL4 Aug. 31 to Sept. 5, 2017	WL5 Sept. 14, 2017	WL6 Sept. 25, 2017	WL7 Oct. 12, 2017	WL8 Oct. 26, 2017	WL9 Nov. 9, 2017	WL10 Dec. 5, 2017	
Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	Vertical Gradient (d/dt)	
-0.38	-0.21	0.08	0.10	0.09	0.09	0.10	-0.16	-0.15	-0.17	
0.01	0.01	1.08	1.06	1.05	0.99	0.99	0.01	0.00	-0.01	
-0.18	-0.17	0.02	0.20	0.01	0.02	0.02	-0.06	-0.06	-0.06	
-0.04	-0.03	-0.04	-0.04	-0.03	-0.04	-0.03	0.01	0.03	0.08	
-0.05	-0.05	-0.13	-0.12	-0.08	-0.07	-0.06	0.02	0.01	-0.15	

In order from top to bottom: PZ6 (WL-C1), PZ-20, PZ-21 (WL-C1), PZ 22, PZ-23 (WL-40/41)

Table 4
Regional Water Table Drawdown Near
Wetlands (MODFLOW)

Reference Point ¹	Drawdown (ft)	Drawdown (m)
C1-a	1.75	0.53
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40/41-a	2.75	0.84
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14-a	22.0	6.71
14-b	2.50	0.76
6-a	0.60	0.18
2b-a	0.25	0.08
A1West-a	2.50	0.76
A1West-b	0.35	0.11
A1East-a	1.50	0.46
A1East-b	0.10	0.03

1) See Figure 1 (Updated), taken from Figure 3-5 of Groundwater Modeling Report
2) Drawdowns < 0.5 ft were extrapolated from Figure 1 (Updated)

Prepared by: DRD
Reviewed by: MAN

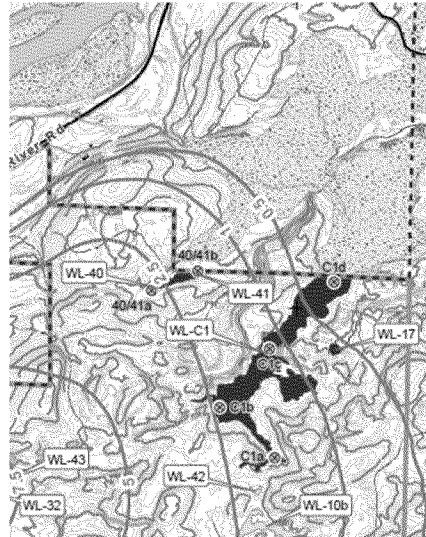
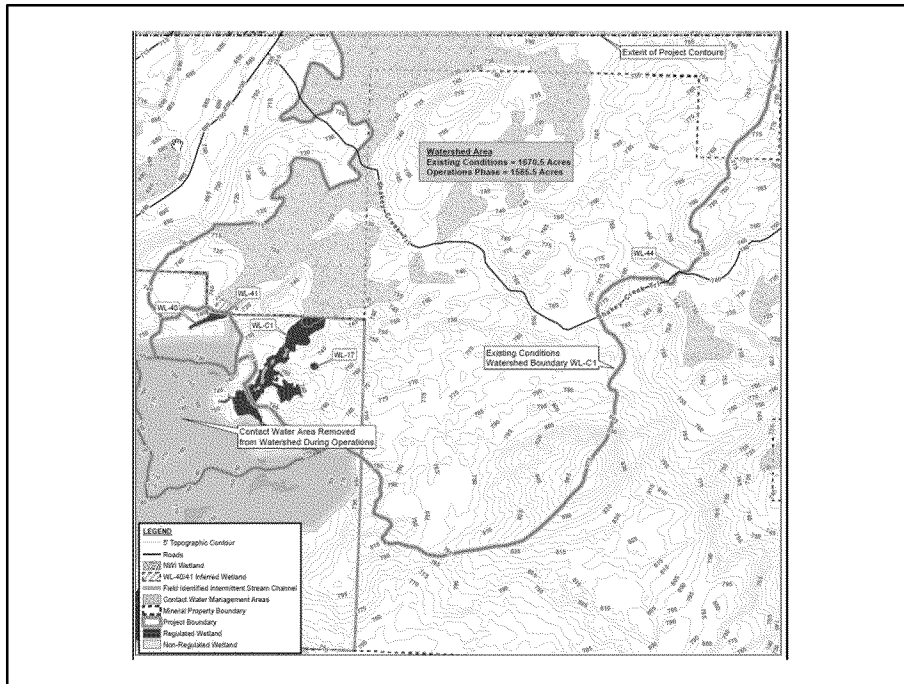


Figure 1 shows the groundwater table interpolated between measured groundwater levels at monitoring points FMW-05 to the south of WL-40/41, and the Menominee River to the north of WL-40/41. The water levels shown on the cross-section are summarized in Table 5. Updated Figure 5-40 shows groundwater contours in the vicinity of WL-40/41 that are based on the measurements in the monitoring wells (the closest of which is) FMW-05 and the Menominee River to which the groundwater drains. The groundwater level measurements shown on Updated Figure 5-40 are from December 2011, with the exception of a few measured data points from 2010 and 2012 to fill data gaps (as shown on the figure). The midpoints of the maximum and minimum groundwater level measurements at the points shown on Updated Figure 4-4 of the *Groundwater Modeling Report* (included with this response document) were used as calibration targets for the MODFLOW groundwater model and vary slightly from the December 2011 water levels shown on Updated Figure 5-40. The MODFLOW calibration target data is summarized in Table 1.



Where is the separation of the perched vs the groundwater driven portions of the wetland complex?